

**Exploring the Notion of ‘Pedagogical Space’ Through Students’
Writings About a Classroom Community of Practice.**

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Abstract

A classroom community of practice has been described in terms of the shared resources and practices used by its participants. One such resource is the organization of pedagogical spaces within the classroom. In an extensive study that employed detailed analyses of video/audio-taped participant interactions, teacher/student journal entries, student-seating patterns and questionnaires, a major interest was in finding student descriptions that assist educators to recognise spaces within the classroom community that facilitate learning. This paper explores written descriptions provided by self-described high and average-ability students as they participated in a primary mathematics classroom over one semester. Student descriptions are analysed in accordance with conditions identified as being conducive to establishing pedagogic spaces such as the nature of participants’ interactions, discursive practices employed, the collective nature of learning, and teacher promoted practices. Implications are drawn regarding the efficacy of the notion of ‘pedagogical space’ for researching learning in the domain of mathematics.

Introduction

The notion ‘community of practice’ has been described as "a set of relations among persons, activity, and world, over time" and as being "an intrinsic condition for the existence of knowledge . . ." (Lave & Wenger, 1991, p. 98). As an analytical tool, ‘community of practice’ has been used in varying degrees to describe the situated nature of learning (Lave & Wenger, 1991; Roth & Bowen, 1995) and the location of knowing within the shared resources and practices of a community (Lave & Wenger, 1991; Roth, 1995). Classroom communities of practice may also be described in terms of the resources and practices its members share to complete common tasks (Roth, 1995). Practices include ‘talking about’, for example, stories, community lore and ‘talking within’ the community, for example, explaining, justifying (Lave & Wenger, 1991). Resources include the artefacts, conventions and interactions that are pertinent to a community (Roth, 1995). Because practices and resources may be shared, they may be said to display physical, social, and conceptual dimensions. As such, the notion of classroom practices and resources can be expanded to encompass the physical and social spaces in which students practice, the norms which privilege certain ways of thinking and acting within those spaces, and the pedagogical scaffolds that enable students to participate in those spaces. The spaces, norms, and pedagogical scaffolds that emerge around shared classroom practices form important constituents of what this author refers to as ‘pedagogical space’.

‘Pedagogical space’ may be said to arise from the work of sociocultural theorists such

as Vygotsky and Leont'ev as they describe the emergence of human development from collaborative cultural contexts. According to Vygotsky (1987), learning results from people participating in contexts where semiotically-mediated social interaction is facilitated. Learning results from participation in shared practice and is mediated by the sociocultural, that is, by those spaces constructed by others in which they share their ways of knowing and doing. It is through participating in historically and culturally situated spaces that a student's relationships to others, to activity, and to the world may be transformed over time to show congruence with the ways of knowing and doing of mature communities of practice - mathematicians, scientists, historians, etc. (Lave & Wenger, 1991). Pedagogy plays a vital role in this transformation process.

Leont'ev highlights the role of pedagogy when elaborating the notion of context. For Leont'ev (1981), specifying the goal of an activity does not stipulate the means-end relationship involved in composing operations to attain that goal. Goal-directed action is a response to a task that incorporates the motive for performing the task, the goal to be achieved, and the conditions that influence performance. Task activity is influenced by pedagogical elements relating to social interaction, tools, and processes. The relationships of the agents involved in the activity (expert-novice, parent-child, teacher-student, student-student, etc.), the tools that they use to engage with the activity (language, symbolic notations, formulae, etc.), and the processes that they follow to complete the activity (individual, collaborative, communal, etc.) all influence goal attainment. From this point of view, learning may be considered to be an independent process, but it proceeds through contexts or spaces that have social, cultural and historical dimensions.

In line with this understanding, van Oers (1998) defines context as being a dynamic construct that:

“actually is a process of adding new meaning to a given situation in order to characterize this situation in terms of what could (or should) be done, and by the same token to exclude (for the time being) alternative interpretations of the required mode of acting” (p. 482).

Context, therefore, may be seen as a process of ‘contextualising’ (van Oers, 1998) where agents make sense of their activity through negotiating actions and by privileging certain ways of knowing (e.g., pedagogical relationships) and doing (e.g., pedagogical practices) over others. From these sociocultural perspectives, therefore, pedagogical space may be said to be an on-going process of adding meaning to a given situation through constructing the situation in terms of what *should* or *could* be done when engaged in shared practice.

In elaborating educational forms of initiation into the culture of mathematics, van Oers (2002) maintains that classroom discourse (e.g., explaining, justifying) plays a pivotal role in assisting teachers to contextualise to students the relationship norms, tools, and processes employed by the mathematical community to progress the knowledge base of the discipline. It is through the mathematical ‘attitude’ of the teacher and others as displayed in classroom discourse that students may be afforded or constrained in their development of a mathematical sense facilitative of their becoming autonomous, critical and authentic participants in mathematical practice.

However, participating autonomously in classroom mathematical discourse requires that some conditions be fulfilled at the individual, group and whole-class levels, and that the positions taken up by individual group members in matters of controversy have their roots in the norms of the classroom community. That is, that the pedagogical spaces constructed by students as they journey towards becoming autonomous members of a classroom community of mathematical practice link individual mathematical thinking (representations) to the cultural, historical dimensions of mathematical practice.

One way of investigating the nature of the pedagogical spaces that students construct as they progress toward becoming autonomous members of a classroom community of mathematical practice is to examine students' 'talk about' a classroom community. Lave and Wenger (1991, p. 109) maintain that 'talking about' a community of practice can give insights into the shared practices and resources of a community once the process of 'talking about' becomes "a practice of its own" even when sequestered in some respects from the mainstream of the community's practice. One source of 'talking about' a classroom community that fulfils this requirement is structured student journal writings where students reflect upon and respond to open-ended questions posed by the teacher.

Journal writing in mathematics has been associated with an increased exposure of students' views about mathematics and its learning (Borasi & Rose, 1989). If maintained over an extended period of time, journal writings may take on the qualities of autobiographies that can provide insights into students' beliefs about mathematics, their levels of confidence in doing mathematics, and insights into students' awareness of changes and influences for change in their understandings of the mathematics teaching/learning process (Southwell, Brady, Harrison, & Lavaring, 1996). In other words, students' journal writings may give insights into the nature of the social spaces that students construct within the pedagogy of the classroom.

This paper examines the first semester structured journal writings of two students operating in a Collective Argumentation Year 7 mathematics classroom. Collective Argumentation (Brown & Renshaw, 2000) is a collaborative way of knowing and doing mathematics situated within the context of a primary classroom community of practice. Key features of Collective Argumentation are the structuring of student interactions through the use of a 'key word' structure (represent, compare, explain, justify, agree, validate) and the use of a negotiated classroom 'values charter' based on the quasi-commitments (See Bereiter, 1994; Lampert 1990) of a scientific community of practice. These values (e.g., openness, honesty, humility, and wise-restraint) scaffold the generation, sharing, communication and validation of ideas within each group and the whole class community.

In Collective Argumentation, the students are guided by the teacher to organise their group discussions so that they (a) individually represent their thinking about a mathematics problem, (b) compare their ideas with other members of their small group, (c) explain their ideas to each other, (d) justify why their ideas should be accepted by the group as being relevant to the task, (e) agree with others on an idea related to the problem that they could present to the class, and then (f) present the group idea, in the form of a co-constructed argument, to the class for discussion and validation.

Method

The context of the study

The Year 7 classroom referred to was situated in a metropolitan primary school located near the centre of Brisbane. The population of the class comprised 15 female and 11 male students drawn from middle and working class backgrounds. The class had been the focus of a year-long, intensive research study (See Brown, 2001). This paper focuses specifically on two female students, Kerri and Terri. Kerri and Terri were chosen for this focus because they frequently partnered each other and interacted with other members of the class during first semester. The students in this classroom were permitted a choice in their seating arrangements and other everyday aspects of classroom life that are normally decided by the teacher - for example, the students were allowed to eat in the classroom and to go to the toilet when they decide.

Research questions

In line with conditions that might facilitate the emergence of pedagogical spaces around discursive practices, student structured journal texts were analysed with the following research questions in mind:

(i) What emphasis did students give in their statements to the discourse practices/resources of the classroom, particularly in relation to explaining and arguing - important practices associated with the formation of a classroom community of practice (Roth, 1995)?

(ii) What did the social positions reflected by students in their journal writings say about the nature of the pedagogical spaces they constructed?

Subjects

Kerri is a student who had attended this school since Year 1. In response to a questionnaire Kerri described herself as being a high ability student who frequently likes mathematics and who always achieves good results in the subject. Kerri was nominated by 14 of her classmates as liking mathematics more than themselves.

Terri is a student who came to the school in the last part of Year 6. In response to a questionnaire, Terri described herself as being an average ability student who frequently likes mathematics and who frequently achieves good results in the subject. Terri was not nominated by any of her classmates as liking mathematics more than themselves.

Kerri and Terri worked with each other 16 times over the 40 sessions of Collective Argumentation conducted in first semester. Terri responded to 33 of these sessions and Kerri to all of these sessions via structured student journal entries. Before entering this classroom, neither student had worked in a collaboratively oriented classroom for any sustained period of time.

Materials and procedure

Early in first semester each student was provided with a Mathematics Journal Reflection sheet (see Figure 1) which they pasted onto the inside front cover of their journal notebooks. The questions were adapted from a structured learning-log model advocated by the Department of Education, Queensland (1996). At the completion of each Collective Argumentation session students were provided with a 15 to 20 minute period in which to respond to the session in their journals. Response time was provided either immediately following each session or at the commencement of the next class session if lunch-time intervened.

Mathematics Journal Reflection Sheet	
Question No.	Question Text
01	Today's mathematics session was about?
02	Today I worked with?
03	What did you do in today's math session?
04	Why did you do it (the math) that way?
05	What did you learn in today's math session?
06	What did/didn't you enjoy in today's math session?
07	What difficulties did you have in today's math session?
08	What didn't you understand from today's math session?
09	How did you feel about today's math session?
10	How do you feel you worked during today's math session?

Figure 1: Mathematics journal questions provided by the teacher.

The students individually recorded their responses in their journal notebooks. Students typically devoted one page to one Collective Argumentation session and determined for themselves which questions to respond to and how much space to devote to each question. The journals were kept by the students and submitted to the teacher approximately once a month. It was emphasised to the students that the journals were not for assessment purposes and no verbal or written personal feedback was provided. However, general issues raised by students in their journals were sometimes made the topic of a class discussion. Informed written consent was sought and received for the journals to be used for research purposes. Although encouraged to respond to each question the quality and content of responses were determined by the students.

As can be seen in Figure 1, all 10 questions were open in nature with the first 4 questions relating to student perceptions about the nature of the activity engaged in during the Collective Argumentation session (content, partners, personal activity, and motivation). Questions 5, 7 and 8 relate to student perceptions about learning/understanding and the difficulties encountered during the session. Affective perceptions are sought through Questions 6, 9 and 10. It must be noted that the journal questions address each student as an individual and no bias is evident in the questions relating to the teacher's preferred student response.

Results and Analysis

Emphasis given to the production of convincing arguments

Looking at student responses to the journal questions as a whole, Kerri produced 18 and Terri 4 statements relating to the production of convincing arguments (see Table 1 where the bracketed numbers refer to the journal question being responded to).

Table 1: Students' statements relating to the production of convincing arguments.

Day/Month	Kerri's Statements	Terri's Statements
13/03	(1) Proving $10^0 = 1$. (3) I tried to prove $10^0 = 1$, but I couldn't. (5) How to prove $10^0 = 1$	(1) Proving numbers by the power of zero = 1 (6) I enjoyed the challenge of proving the problem.
19/03		(1) How to prove that 3 is a multiple of 150.
20/03		(1) How to prove a

		problem.
26/03	(1) Writing out a problem and saying good reasons for it. (4) There is a lot of good reasons about it. (7) Annie disagreeing with me.	
10/04	(7) Trying to get through to Annie and Chris that I was right.	
16/04	(6) I didn't enjoy our group arguing about what question or problem to do.	
30/04	(6) I didn't enjoy May and Lisa having an argument.	
20/05	(6) I didn't enjoy Terri and me arguing about the cents.	
27/05	(5) Sometimes I can be wrong. (6) I didn't enjoy Terri and Alice in not at first agreeing to do a number sentence. (7) Convincing Terri and Alice.	
28/05	(5) Sometimes I have to admit that I am wrong. (6) I didn't enjoy the argument our group had.	
03/06	(6) I enjoy writing it on the white board. I didn't enjoy everyone arguing.	
05/06	(6) I enjoyed the big argument and I didn't enjoy Terri being so quiet when I explained my explanation to her.	
11/06	(5) I am not always right.	

The emergence of a shared practice of producing arguments.

As can be seen in Table 1, Terri's reference to the production of convincing arguments is minimal, relating to only three Collective Argumentation sessions. The congruence of the two students' statements relating to 'proving' and the 'challenge of proving' indicate the teacher's promotion, early in the semester, of this aspect of mathematical talk. Kerri's consistent reference to the production of convincing arguments throughout the semester, however, indicates that the production of convincing arguments was an emerging shared practice in this classroom. This is indicated in a number of ways. Firstly, Kerri's substitution of the term 'proof' with '*saying good reasons for it*', '*get(ing) through*', '*convincing*', '*not agreeing*' and '*argument*' indicate that Kerri is appropriating a teacher promoted practice that is not just requisite, but also meaningful - a move which is crucial in linking abstract definitions to personal understanding (Lemke, 1992).

Secondly, Kerri's utterances '*Annie disagreeing with me*', '*our group arguing*', '*everyone arguing*' and '*the big argument*' suggest the emergence of a shared practice. The outwardly oriented to and fro references to immediate interactions (statements relating specifically to Annie, Chris, Terri, Alice) and group/whole class interactions (statements relating to May and Lisa, our group, and everyone) suggest the notion of 'everyone else is doing it' (Roth, 1995) and imply that Kerri considers the emerging practice of producing convincing arguments to be shared not only in her immediate setting but by the whole class community.

Pedagogical spaces that emerged around the production of arguments.

Kerri's statements as recorded in Table 1 show an expansion of the pedagogical spaces that emerged around Kerri's interactions with Terri and the other class members over the course of first semester. During the first months of engaging in Collective Argumentation, Kerri's focus in her statements is on individual performance, for example, "*I tried to prove $10^0 = 1$, but I couldn't*". These

statements are to be expected from a student who has not worked in a collaborative classroom before and who perceives herself to be a high achieving student as many teachers in Western classrooms use individual competition to structure their pedagogy (Rogoff, 2003). However, during the third, fourth, and fifth months of engaging in Collective Argumentation, Kerri's emphasis on individual effort fades and her statements begin to encompass group processes – saying, disagreeing, trying to get through, arguing, convincing. This emphasis on group processes remains throughout the semester and recognises (sometimes negatively) the contributions of others to Kerri's learning – contributions that culminate in Kerri's insight that *"Sometimes I can be wrong."*

However, for the most part Kerri states that participating in these group processes lacks personal enjoyment. Kerri's perception of herself as a high achieving student and the majority class perception of Kerri as a student who likes mathematics more than them, may bestow an 'expert' status on Kerri which may be put at risk if the arguments she produces were found wanting by other students. This lack of control may be the cause of Kerri's lack of enjoyment within the pedagogical spaces that emerge around the practice of producing convincing arguments. However, it is interesting to note that during this time, Kerri begins also to positively value her arguing with others, (e.g. *"I enjoyed the big argument"*; *"I didn't enjoy Terri being so quiet when I explained my explanation to her"*) and that this valuing occurs around the time when Kerri's statements reflect self-awareness (*"Sometimes I can be wrong; Sometimes I have to admit that I am wrong; and, I am not always right"*). This implies that Kerri's participation in the pedagogical spaces that have emerged in this classroom around the practice of producing arguments has contributed towards raising Kerri's awareness of herself as a mathematician - sentiments associated with thinking like a mathematician acting in a community (Pimm, 1995).

The lack of statements made by Terri that relate to the production of arguments indicates that Terri rarely constructed or at least did not value the pedagogical spaces in the classroom that emerged around this shared practice. This could be due to the role that she may have assumed when working with Kerri and others. Terri's statements relating to the *"challenge of proving"* and *"how to prove"* indicate that in the first part of the semester Terri was a 'newcomer' (novice) in the group. Terri's novice-like status with Kerri is further suggested by Kerri's statement *"I didn't enjoy Terri being so quiet when I explained my explanation to her"*. However, Terri's participation in the pedagogical spaces that emerged around participating in shared practice is better illustrated when we look at the centrality of 'explanation' as a social event within this classroom.

The centrality of explanation as a social event

Both Kerri and Terri recorded over 25 statements directly relating to the centrality of explanation in their classroom mathematical lives. For ease of perusal only those statements deemed essential to the analysis are presented in Table 2.

Table 2: Students' statements relating to the centrality of explanation as a social event

Day/Month	Kerri's Statements	Terri's Statements
11/03	(6) I felt a bit nervous when I explained it to the class. So that really means that I didn't like explaining.	(6) I enjoyed explaining to the class about my ideas – I had courage that I could do it.
13/03		(4) So we can give the class our ideas and they can do the same.

17/03	(5) How to write or explain a problem mathematically. (6) I enjoyed explaining in front of the class.	(4) So that we could share our ideas around the group.
26/03	(5) People are frightened of my equations. (6) I didn't like people getting scared of an equation. It's only maths! I would explain it to them if they gave me a chance.	
14/04	(6) I didn't enjoy other people in the group leaving out Terri. Unfair I think!	(6) I didn't enjoy being left out. (7) I had trouble because people would not let me explain properly.
15/04	(6) I didn't enjoy explaining. I was nervous and caused everyone to be confused.	
16/04	(6) I enjoyed explaining it.	(3) We went up and explained our ideas to the class. (4) So that we could get new ideas.
28/04	(7) Explaining the answer to Pam.	
30/04	(4) It's the most mathematical and it would look very hard and everyone would get confused. (6) I enjoyed explaining it to the class.	(3) We presented our problem and then compared it with the rest of the class. (4) So that we could look at the same maths problem in different ways.
01/05	(6) I didn't like when we asked first and we couldn't present it first.	
07/05	(5) Simple words are hard to explain. (6) I didn't enjoy two groups explaining the same things.	
19/05	(5) Explaining my ideas. Other people in the class never understand what I say. (6) I didn't enjoy Terri telling me that she understood and when she explained it to the class she didn't understand.	(4) So that we could get feedback from other kids. (6) I enjoyed the challenge and I feel more confident.
20/05	(5) Everyone doesn't understand what I say at the first time I explain.	(6) I didn't enjoy how we explained. (7) Working out the bit that Kerri did.
21/05	(5) Explaining isn't easy.	
26/05		(4) So that we could have a chance to see how other people solved the problem. (6) I enjoyed presenting with the group. (8) One of the ways that my group did it before they explained it again.
29/05	(6) I didn't enjoy not presenting my problem. I enjoy explaining my problem.	
10/06	(6) I didn't enjoy Terri being so quiet when I explained my explanation to her.	
11/06		(4) So that we could get some feedback from the class. (6) I enjoyed when I understood how to do it a different way.

As can be seen in Table 2 explanation is a consistent and central event for these two

students when doing mathematics in this classroom. Both students use of the pronoun “I” early in the semester and their references to ‘*nervousness*’ and ‘*courage*’ suggest that ‘*explanation*’ was initially constructed as a personal event that elicited emotional tension. This tension may relate to the issues of ‘*perceived status*’ and ‘*novice-ship*’ as referred to earlier. However, as the semester progresses both students begin to take up more outgoing social positions within the pedagogical spaces that emerged around the practice of explaining.

Kerri’s position within the pedagogical space is similar to that adopted by her for the shared practice of producing convincing arguments. For Kerri, ‘*explaining*’ remains mainly a personal event throughout the semester. It is ‘*my ideas*’ or ‘*my problem*’ that is communicated through the medium of ‘*my explanation*’. However, within the pedagogical spaces suggested by Kerri’s explanation statements, Kerri appears to simultaneously construct several social positions that are not coherently related.

At one point Kerri refers to Terri being left out of the group as being “*unfair*” (a statement confirmed by Terri). This statement implies that Kerri has taken up a social position of concern about the co-operative dynamics within the pedagogical space. Later, however, Kerri refers to a motive behind an explanation “*It’s the most mathematical and it would look very hard and everyone would get confused*” - a social position of domination within her pedagogical space. Later still, Kerri refers to disliking that “*when we asked first ... we couldn’t present first*” - a social position of competition. These statements convey the complexity of the interactive positions adopted by students within the pedagogical spaces that emerge around a classroom practice.

Within the complexity of these interactive positions Kerri’s awareness of the nature of mathematics and of herself as a mathematician is once again brought into consciousness. Statements referring to “*people are frightened of my equations*” and “*I don’t like people getting scared of an equation. It’s only maths!*”, “*other people in the class never understand what I say*”, and “*everyone doesn’t understand what I say at the first time I explain*”, suggest that Kerri is beginning to question what Pimm & Love (1991) refer to as ‘the official view’ of school mathematics - where mathematics as traditionally taught in schools and higher education institutions is considered to be the only true form of mathematics. Kerri’s statements referring to “*simple words are hard to explain*”, and “*explaining isn’t easy*”, suggest that Kerri’s social position within the pedagogical spaces of this classroom may be negotiable and open to change as she encounters the growing confidence of other students to challenge this ‘official’ point of view - as suggested by Kerri’s statement “*I would explain it to them if they gave me a chance*”. This sense of growing confidence is conveyed within Terri’s explanation statements, for example, “*I enjoyed the challenge and I feel more confident*”.

In contrast to Kerri’s statements, Terri’s statements suggest that, for her, explanation is a socially situated transaction where other classroom participants share an understanding of the nature and purpose of the transaction. Statements made early in the semester by Terri, such as “*so we can give the class our ideas and they can do the same*”, and “*so that we can share our ideas around the group*”, suggest that an initial ‘ground rule’ (Edwards & Mercer, 1987) of explanation in the pedagogical spaces of this classroom is to introduce items of knowledge and assumption into the social

domain as things to be described and compared. This description and comparison of ideas is recorded again later in the semester, when Terri states that we explained our ideas so that we could “*get new ideas*”, “*look at the same maths problem in different ways*”, “*get feed back from other kids*” and “*have a chance to see how other people solved the problem*”. These statements also imply an emerging sense of the different functions of the symbolic language of mathematics, that is, (a) to combine new ideas/perspectives in order to compose a problem’s solution, and (b) to signify different ways/solutions processes (Pimm, 1995). This emerging sense of the functions of mathematical language suggest that Terri is beginning to view the shared practice of explanation as a ‘semiotic tool’ (Vygotsky, 1981) that she can use to promote her understanding of mathematics - a view reflected in her statements I didn’t understand “*one of the ways that my group did it before they explained it again*” and “*I enjoyed (it) when I understood how to do it a different way*”.

Discussion

The different positions constructed by Kerri and Terri within the pedagogical spaces that emerged around the shared practices of arguing and explaining are illustrated through their use of the pronouns “we” and “I”. The use of “we” in a statement can include the one writing, a normative agent (usually the teacher or textbook in school mathematics), and signal a partnership with others. For example, in the overall context of Kerri’s explanation statements her use of the pronoun “we” in the statement “*I didn’t like when we asked first and we couldn’t present*” suggests a partnership with others. However, Kerri is given precedence in the statement through the use of the pronoun “I”. This suggests that Kerri’s use of “we” may simply be a part of an established chain of personal reference rather than as somehow introducing a learning partnership into the pedagogical spaces that she constructed. For Kerri, explaining emerges during the semester within pedagogical spaces that mainly signal it as being a personal event.

On the other hand, Terri’s use of “we” in her explanation statements suggest the establishment of learning partnerships within the pedagogical spaces that she constructed. “*So that we can give the class our ideas and they can do the same*”, “*so that we can get feed back from other kids*”, and “*so that we could get some feedback from the class*”, suggest that Terri’s use of “we” is not to be considered as part of an established chain of personal reference, but as introducing new material into the text of her explanation statements - the ‘other’. For Terri, ‘explaining’ emerges during the semester within pedagogical spaces that signal it as being a communal event. It is ‘*our ideas*’ or ‘*our problem*’ that is communicated to the class through the medium of ‘*presenting with the group*’ so that “*we could get feed back*” from others.

Terri’s use of the collective “we” in her explanation statements suggests, therefore, a type of membership in pedagogical spaces that stands in contrast to Kerri’s. This suggests that the pedagogical spaces that emerge in this classroom around shared practices may be constructed differently by students as they take up social positions that privilege certain ways of knowing and doing.

Conclusion

The above analysis of student journal statements suggests that within a classroom community of practice pedagogical spaces emerge around shared practice. Students’ statements imply that within these pedagogical spaces students’ representations/ ideas/ points of view may be seen as social resources that have the potential to promote an awareness of the ‘self’ as a mathematician and an understanding of the

nature of knowing and doing mathematics. The above analysis also suggests that student written responses to structured journal questions ('talk about') is productive of gaining insights into the ways students learn to 'to talk' within the pedagogical spaces of their local classroom community.

The journal statements provided by Kerri and Terri point to the changing patterns of participation in the pedagogical spaces of this classroom. The statements provided by Kerri in Tables 1 and 2, evidence the beginnings of a transformation in her perceived membership (position) within the practices of this classroom. Initially adopting a social position of one who "*was right*", didn't enjoy others "*not at first agreeing*" with her, would explain "*answers*" to others "*if they gave (her) a chance*" and who viewed "*the most mathematical*" as looking "*very hard*" and confusing to others, Kerri's statements reveal the potential for her to construct a new social relationship with others in this classroom. The potential for this new social relationship to develop is evidenced in Kerri's heightened awareness that she was "*not always right*", that others were "*frightened of (her) equations*" and that explaining mathematics to others "*isn't easy*" and is about "*everyone*" understanding even if she has to explain again.

Terri's statements also evidence transformative effects in her perceived membership within the practices of this classroom. From being a student appearing to adopt the stance of a newcomer (novice) who is sometimes "*(left) out*" and whose position it is to learn "*how to*" and to "*explain properly*" when others "*let*" her, Terri's statements reveal the emergence of a student who is prepared to adopt a courageous and confident stance - the stance of one who is capable of collaborating with others to get "*feedback*", "*new ideas*" and "*different ways*" of looking at and understanding mathematical problems.

If teaching is to be viewed as a social process that creates connections between the domain of the personal, local and experiential and the domain of the social, general, and more formal, then movement by students within and between these domains and the forms of representation and language that mediate such movements need to be studied and recorded. The notion of 'pedagogical space' seems efficacious in assisting researchers to understand the multiple types of participation and changing forms of membership that take place in classroom communities of practice and the types of 'tools' that may assist students to make the transition from the personal to the social. This paper has provided evidence that students within a Collective Argumentation mathematics classroom construct differently the pedagogical spaces that emerge around classroom discursive practices and that this construction is an on-going process of adding meaning to a given situation through characterising the situation in terms of what *should* (Kerri's characterisation) or *could* (Terri's characterisation) be done when engaged in shared practice. Evidence is also provided that students' representations/ ideas/ points of view may be viewed by students within these spaces as shared social resources that have the potential to promote mathematical understandings and an awareness of the 'self' as acting in a community of practice.

The emergence of pedagogical spaces within this classroom did not happen by chance. The collective practices and resources in this class have been scaffolded by the teacher over a period of time as he introduced and supported the students in producing explanations and convincing arguments. The physical classroom setting

that facilitated the emergence of these pedagogical spaces was organised around the negotiated decisions of the students and teacher. This scaffolding and classroom organization permitted students to encounter mathematics within pedagogical spaces that assisted them to compare, reflect upon, reject, modify, and expand their ideas through accessing shared practices and to place themselves in the positions of mathematicians so as to see and to know something of what a mathematician *could* experience.

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